Redefining toys, games and entertainment products by teaching about playful interactions

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Abstract: This paper describes how students are taught to design (computer) games and toys in a broad sense of the word at the Department of Industrial Design at the Eindhoven University of Technology. The curriculum is highly project driven, which means that students acquire a large amount of hands-on experience during concrete projects. One major theme within the department is the design of playful interactions, which focuses on the design of innovative concepts that support expressing oneself and exploration. In this theme, we design for opportunities and exploration instead of goal-oriented products. Our educational approach is illustrated with examples both from an assignment on game design and design projects on playful interaction.

Keywords: play; user-centred design; design for children; locative games; storytelling; open-ended play; competency centred learning; learning.


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Caroline Hummels is an Associate Professor and Director of Education of ID. She also has a background in Industrial Design Engineering (Master and PhD). In her work, she focuses on both the educational profile of ID through competency-centred learning, and her personal topic of aesthetics of interaction and ethics in design.

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Philip Mendels is a PhD Student and Student Project Coach at ID, where he also obtained his Master’s degree. He has a passion for interactive products, software and installations that enable people to express themselves and that trigger their imagination. Recurrent themes in his work are storytelling, animation and audio/adventure games. Currently, he focuses on people’s digital collections.

1 Introduction: learning at industrial design, TU/e

In this paper, we describe how we teach students to design innovative Playful Interactions (PI) in the context of our industrial design (ID) department. We first explain the general set-up of the ID Department, which was founded in 2001 and then describe one of the themes within the department were students are taught about creating innovative toys, games and entertainment applications. Subsequently, we illustrate our curriculum by describing the context of an assignment and three design projects related to PI.

1.1 The educational focus and model of ID

The Department of ID at the TU/e distinguishes itself by its focus and its approach from other ID departments. Designing intelligent systems, products and related services is the focus of our Department of ID in Eindhoven. We believe that designers do not only have to develop the next generation of digital systems and products with which people can pursue their lives, they also have to investigate what kind of life and society we want these products to support (Hummels and Frens, 2009). This asks for a new type of innovations that can transform our society including the lives of people. Because new technology is potentially capable of transforming our world in ways that we cannot know beforehand, we educate students to apply new technologies in new ways, driven by a design vision of what our (social) world could be like and based on solid user research.

We believe that this also asks for a new type of designer who is able to learn in a specific way and to integrate different fields and abilities.

Firstly, we educate our design students using a competency-centred learning approach in which we teach them to learn (what, how and why) in order to have the ability to creatively and flexibly deal with the large amounts of constantly evolving information in our ‘knowledge era’. Therefore, our students work as ‘junior employees’ in an ‘authentic’ context on projects with external clients and on assignments and modules to acquire the competencies required for becoming interactive/intelligent system designers.

Competency-centred learning offers them the opportunity to give equal weight to knowledge, skills and attitudes and stimulates students to learn by doing. Within our department, a competency is defined as an individual’s ability to select, acquire and use the knowledge, skills and attitudes that are required for effective behaviour in a specific professional, social or learning context. So, it offers a holistic view of design, where the student integrates in our case ten competency areas related to users, (interaction) design, technology, business, society, modelling, processes, ideation, teamwork and self-directed learning (Hummels, 2008). Moreover, it asks for designers working on the intersection of design, engineering and science (Bartneck and Rauterberg, 2007) which is an interesting challenge given the different paradigms of these three different disciplines.
1.2 Design approach

Competency-based learning is especially suited for learning about design because it has always been a profession which is learned and performed by practical application in combination with the acquisition of theoretical skills. Therefore, all our students are introduced to the reflective transformative design process, which is an open, flexible process that stimulates reflection and exploits the synergy between making and thinking (Hummels and Frens, 2009), as shown in Figure 1.

Developing design solutions in the centre of this model can be seen as a process of taking decisions based on too little information. The breadth of the solution domain and the interdependence of individual solutions, the design brief and vision makes it impossible to determine beforehand if a decision is the right one. Therefore, we consider design decisions conditional. Moreover, this process knows two axes: vertically we distinguish drives and horizontally we distinguish strategies.

**Drives** (vertical axis): we view the design process as a process where insight into the design opportunity and solution domain is achieved by continuous information gathering. Next to the design solution itself we see two drives for information gathering. The first drive is information gathering to direct the design decisions through the designer’s vision (top circle). We stimulate the development of innovative solutions to transform society, and therefore encourage students to create a vision on transformation from our current reality to a new reality through an interactive/intelligent system. We encourage students to search for innovative solutions that are meaningful and valuable for users and our society. The second drive is information gathering to explore and validate design decisions in society with users (bottom circle). Because meaningfulness and value are person and context-related issues, the possibilities and solutions have to be explored and tested in society.

**Figure 1** The reflective transformative design process, with the different activities that designers use during a design process (see online version for colours)
Strategies (horizontal axis): the drives are incorporated within two strategies that generate information and that reciprocally provide focus for each other. The first strategy revolves around design action, both synthesising as concretising, like building experiential prototypes (left circle). This strategy produces experiential information for the other activities in the design process. The second strategy revolves around thinking: analysis and abstraction (right circle). It produces a more formal kind of information that (again) feeds into the connecting activities. Both strategies are equally valuable and should frequently alternate throughout the entire process.

Dependent on the person, context or phase within the design process, the students determine where they start and the order of the activities. In this way, the process supports flexibility and individuality. Moreover, every time the student switches activities an opportunity for reflection occurs, therefore we stimulate frequent changes from one activity to another.

1.3 Assessing growth, competence of designing and vision

Within our department students are responsible for their growth as a designer, the development of their specific overall competence of designing and their vision on design, of course with help from coaches and experts. Consequently, every semester students compose their own programme by selecting a project (which focuses on integration of competency areas) and several assignments/modules (which focus on specific competency areas), based on their personal development plan. At the end of each semester they are assessed on the development of their overall competence of designing, their vision on design and their growth as a designer, as shown in their ‘showcase’ (see Figure 2). They use the instrument of reflection in action, on action and for action (Schön, 1983) to evaluate and discuss the quality of their deliverables, the development of the different competency areas, the control over and path within design process as well as their attitude. They can support these reflections with the oral and written feedback they received from their coach, assignors, lecturers and experts on their learning activities.

The assessment consists of an exhibition of all projects, the evaluation of the showcase, a meeting between the assessor and the student and final a plenary discussion with all assessors and coaches to finalise all tentative verdicts. The students do not receive any grades for their learning activities and the outcome of the assessment can simply be

1. promoted to next block
2. conditionally promoted to next block with specified conditions
3. a hold in which the student has to redo the current block with specific learning activities that help him/her to work on the weak spots.
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Figure 2 An interactive showcase is the student’s tool to demonstrate and communicate development of the overall competence of designing and growth as a designer. This still is from the interactive showcase made by Emin Sinani, a second year Bachelor student (see online version for colours)

One of the main challenges for our assessment procedure is the overall agreement on the quality and development of students. Therefore, we are currently building a frame of Reference with example projects and showcases to entice the discussion on quality and our view on the graduates we deliver.

2 The theme of PI and related learning activities

Within our department, we use a variety of themes to explore and to develop the overall focus of designing interactive/intelligent systems/products/services. Themes are fields of interests within the design and research area on which the ID Bachelor and Master projects focus, but they also create links to other learning activities such as assignments and modules. Examples of themes are wearable senses, medical care and virtues and values. Most importantly, we have developed themes to cluster students’ projects in order to strengthen the link between research and education, between the different research groups with their own expertise, among Bachelor, Master and PhD students and employees, as well as the link among the university, industry, commerce and other external partners. We believe that it is only possible to really design for intelligent systems, products and services at the intersection of design, engineering and science, if we use and share the expertise of the entire ID community. By integrating education and research, as well as the different people, we can expand the body of knowledge and expertise, and bring the department at a higher level. Last year we have started working with 12 themes, of which two of them also physically integrate students and staff, education studios and research labs. Although this is a challenge due the different backgrounds of our employees, which makes it sometimes hard to speak each other’s
language, the size of the themes (up to 8 staff members and 50 students), the close cooperation on projects and the integration of research and education, appears to have a positive influence on communication and extending the overall knowledge, although we did not have the time yet to fully evaluate the impact of using themes.

One major theme within the department is the design of PI, which focuses on the design of innovative concepts that support expressing oneself and exploring the (game) world. Within the playful interaction theme we think about a redefinition of toys, games and entertainment products and services that can support the human growth, collaboration and competition, and builds on the options offered by today’s technologies and multimedia networks. Role playing, narrative and scenario building will be seamlessly integrated into intelligent products and services that optimise man’s desire for ritual, leisure, entertainment and escape. Instead of focusing on the toy or game itself, PI enables students and staff to focus on the whole system with (networked) technology, products, services and users within a societal context, and the interaction between them. PI focuses towards opportunities and invites designers to create a vision in this field thus exploring new roads.

To teach students about the design of PI, we provide design projects in the context of games, sports, learning, theatre and other forms of expression. In addition to the design projects, assignments such as user focus and perspective basics teach students to develop empathy with the user and to iteratively develop and make explicit the interaction scenarios for their designs (Preece et al., 2002). Furthermore, besides the more general topics (e.g. about ID, User Focus, Business Processes and Integrating Technology) that are related to our competency-based learning model, we provide Bachelor assignments and Master modules that are more specifically related to PI.

2.1 Main topics addressed within PI

Because students compose their own programme, those students who are interested in PI can select several assignments. For example, they are taught the basics of game development in an assignment about game design (see Section 3 for more details). Additionally, there are separate assignments about the design of board games and computer games. The assignment ‘creative programming for designers’ teaches students some basic concepts of programming. In the assignment ‘designing for children and elderly’ students are taught about theories of life span development (Berk, 2008) and play (Scarlett et al., 2005). The students directly apply the knowledge they acquire in these assignments in their design projects in which they design interactive games or other products for children and elderly. In an assignment about ‘persuasive design’ they are taught to reason about designing with the intention of changing people’s behaviour (Fogg, 2005). These skills and knowledge are applied in design projects on serious games or other concepts with the intention of influencing people’s behaviour, for example, in supporting social interaction between elderly or in motivating children to play physical games (Weinberg and Gould, 2003). Furthermore, students are taught about emergent behaviour and creating games through decentralised systems in an assignment about ‘emergent behaviour and adaptive structures’ and one about ‘modelling complex systems’. This knowledge is applied in projects were students create games using decentralised systems that show emergent behaviour.
The three main topics within PI are:

1. **Design of games and controllers**: projects in this category cover the design of computer games, using new interaction styles and game controllers.

2. **Design for exploration and movement**: projects related to this topic create opportunities for players to explore a (virtual) world, or play physical or sport-like games.

3. **Design for expression (e.g. storytelling, theatre and musical expression)**: projects in this category examine how to provide opportunities to people to express their emotions and opinions, to jointly create stories or to create technology enhanced performances.

The following sections provide one example of an assignment and three examples of design projects related to the PI theme. The three design projects illustrate various components of designing for PI. The descriptions focus on the design opportunity, the process followed, the validation process through user testing and a description of the final design. The first project focuses on designing for expression and describes a storytelling system for children, the second project focuses on designing games and describes a locative game, and the third project focuses on designing for exploration and describes interactive open-ended games for children.

### 3 Assignment on game design

The assignment game design provides students with the opportunity to combine practicing their design skills with learning about a specific topic related to designing challenges and protocols in the contexts of games. The aim of the course is to stimulate students to produce a prototype of a simple game. After the assignment, students have to be able to apply simple game-design tools and to analyse game structure thus providing them with a basis for further game design education.

The aims of the assignment are to:

- make students aware of the processes that are important in game development
- introduce students to the history of computer games
- get students acquainted with basics of game theory and apply this game theory: what is it and what are we researching at the TU/e?
- make students aware of the ethical choices they make when designing a game
- get experience in the process from idea generating till the writing of the code for a simple game.

The assignment (56 hr in total) consists of lectures on game theory, prejudices about videogames, game history, game play and game development (Crawford, 2003; Fullerton et al., 2004; Salen and Zimmerman, 2003). Students are also given the opportunity to play videogames. Furthermore, students are asked to produce short papers and a video, to analyse game play and to produce game ideas.
Every assignment day (seven in total) consists of three elements: presentations (either by assignor or students), experience (the playing of games or researching different elements of game play) and the actively reflecting on what students have been offered and experienced.

When developing this course, there were certain doubts about the combination of theory and practice, for example, due to the limited amount of time for the assignment. The program not only consisted of theory and getting acquainted with game-development, students had to master also a platform that was new to most of them. But as already stated in the reflective transformative design process, also in an assignment theory merged with praxis quite organically.

For instance: in one of the first meetings students were asked to produce a tree-diagram of a video game. It took a while, and some needed feedback, but most of them delivered a tree diagram of their favourite game. In the end of the course, when they were asked to deliver the concept of their final prototype, most of them produced, without being asked, a tree diagram of the game play. They started using terminology of game development when the occasion called for it. This is the essence of our learning model, learning new knowledge and skills and having the attitude to apply it independently, showing effective behaviour in a specific professional, social or learning context.

The final games students produced varied from cunning puzzles to interesting ideas that certainly indicated students had not only absorbed some of the theory on the list of the course, but were also able to incorporate this in a prototype. They were actively able to alternate between ‘thinking’ and ‘making’, between analysing and synthesising. Although the majority of the students were in their 1st year, and did not have any knowledge of the platform they used before entering the course, they still managed to present a working prototype of a game level that communicated the game play in a satisfactory way. The reasons seem threefold:

- students were working in what they regard as their own domain
- the theory could be applied to real game-developing
- because the platform is generic, students did not have to spend too much time on learning the technology but could relatively easy apply the theory and their creativity to their ideas.

The feedback from the students suggested that the program consisted of too many different elements. They valued the combination of theory and hands-on developing but would like to have more time for the latter. Students now had to produce a game in 2 weeks (equals 16 hr), but in their experience they would be able to achieve better results when they would have 3/4 weeks for the final assignment. Students valued the assignment positively. They had the impression that ‘they were really learning something, meaningful, on several levels’.

In retrospect, the integrated approach of combining theory with game development, tried to cover too much ground in a limited time span. Evaluations show that it might be more rewarding for students to focus on a specific genre of computer games and to offer a more concise theoretical model rather than to get them acquainted with the complete area of game-research. This approach is valuable for projects, but appears too ambitious for a 56 hr assignment.
Related to the competency model as used by the TU/e, students gained experience and knowledge in the competency area ‘ideas and concepts’: students went through the complete development cycle, from idea generating till appraisal. Moreover, there was development in the competency areas integrating technology, as well as sociocultural awareness and form and senses.

Keeping the aims of the course in mind, in the future, there can be more emphasis on sociocultural awareness, to stimulate a critical approach and designing business processes that has been neglected somewhat in this part and at least needs to be mentioned in a – first – game development course.

4 Design case 1: storytelling for children with the Junior Director

The purpose of this project was to explore how the possibilities of computer animation and the playful interaction style of toys can be combined. Or rephrased: How can children create their own animated movies in an embodied way? Four Bachelor students (Madelon de Haas, Meerthe Heuvelings, Patrick Leijte and Maartje van ‘t Sant) conducted the project during the first semester of their second year, in nine project weeks (converted to fulltime).

The final physical result of the project is a fully functional prototype called the ‘Junior Director’ (Mendels et al., 2009). This is a portable device, including a camera, a screen and several controls, that enables a child to record its environment along with animations that can be added and controlled in real time (see Figure 3). For example, a child can make a video of an animated dragon flying over the LEGO-castle that she/he has just built, or a video of King-Kong hanging from a real church in the street.

Figure 3  The final Junior Director prototype being tested at an elementary school (see online version for colours)
Also more complex play situations can arise: a child (the director) can record movies that include one or more friends (actors) interacting with an animation. Since the system does not project graphics in the real world, the actor cannot see the animation. Therefore, the director has to explain what is happening or what the actor should do. It is very exciting for the actor to see the recorded movie, because now she/he actually can see his/her interaction with the animation for the first time.

This is explained in the following scenario:

Julia and Andrew are playing with the Junior Director. They decide to record a scene in which the knight has to get past the dragon to get to the treasure. Julia wants to be the director this time. Andrew takes a toy-sword and puts on a knight’s helmet. Julia places a physical box with toy jewellery on the ground. They decide that the dragon first forces Andrew to walk backwards, and that after that Andrew should force the dragon to go backwards. Then Andrew should avoid one of the dragon’s fireballs and then lethally strike the dragon with the sword. Julia aims the device and positions the dragon so that it is in-between Andrew and the treasure. Then she says: ‘Start! Walk backwards’, and puts the device in recording mode. When Andrew is with his back against the wall it is his time to attack. Julia moves the device along with Andrew until the dragon is with its back against the treasure again. Then she calls ‘Dodge!’ to Andrew and at the same time makes the dragon spit out a ball of fire. When Andrew stands up again and strikes the dragon, Julia makes the dragon fall down. Andrew goes to the treasure. Together they look back at the video, and Andrew laughs when seeing himself fighting the actual dragon. They discuss points for improvement and decide to do another take.

In this project, the students worked on various competencies, combined synthetic and analytic phases in their approach, and worked on their vision regarding the subject matter in relation to society. We will elaborate on these points using the design process of the Junior Director project.

As in most projects at our course, the students went through an extensive ideation phase before focusing on the final concept. The students were challenged to have a critical look at the project description, which helps them to obtain a critical attitude and eventually to form a vision. Using various idea generation techniques, ten illustrated ideas, ranging widely from magic mirrors to augmented puppetry systems, were developed into three concepts with illustrated scenarios. After this creative phase, the students used a more analytical approach for selecting the final concept. Requirements were set based on literature research about children, the project description and by reflecting on the generated ideas. The students learned that requirements are not just predefined elements, but they can evolve from exploration and reflection during the design process. Finally, the concept of the Junior Director was selected based on a Must-Should-Might analysis, an idea selection method that some of the students had learnt before in an assignment. An example of a strong point of the Junior Director was that it supports different ways of play (social and independent) for children of different ages.

After this choice the students took again a more explorative approach by creating a range of non-electronic prototypes that challenge the standard ways of operating handheld devices. These included amongst others a device that has to be operated by two children together and a device operated like binoculars (Figure 4). Here, the students applied as well as improved ideation skills and design skills such as foam and cardboard modelling. For the final prototype, the students worked on their technology competency
by learning to program an interface and animations in Adobe Flash (Action Script 2) in combination with Phidgets (sensors and actuators that can be easily connected through USB).

*Users* were involved in the project for *validation* in two occasions. The first prototypes were tested at an elementary school with 1st graders. This gave the students a first idea about the children’s understanding of the concept and ability to create simple stories, related to the specific ways of interacting with the prototypes. The final prototype was later tested with 6th graders. It showed that the children had lots of fun playing with the final prototype, and that the actor(s) and director were actively discussing the play/scene before, during and after recording.

The *Business processes* competency was perhaps the least addressed in this project. A client was involved but was more focused on innovation than on feasibility. The students did think about embedding the concept in a platform with related services. A website can be created that provides popular cartoon content for download. This site can also function as a portal for viewing each other’s animations. Actor and director can practice to become more skilled at making movies in which the interaction between the animations and the actors looks seamless. Eventually, the above-described scenario can lead to online contests for the most realistic or perhaps funniest dragon-fight. It can also be considered an option that children create their own animated or non-animated characters for use with the Junior Director.

A clear *vision* is not something that is exactly defined through one project. The students did show a critical attitude and reflected on the influence of this project on society. The students partly chose for the concept of the Junior Director because it does not try to replace more traditional ways of playing: it still challenges the children to dress up and create their own props and environments. In comparison with most electronic toys it also requires much more imagination (especially for the actor), physical activity and social play (although the latter two are also being acknowledged by technologies such as the Nintendo WII).

*Figure 4* Explorative prototypes containing paper characters that can move along translucent plastic instead of showing animations on a digital screen are tested at an elementary school (see online version for colours)
A disadvantage of the relatively large amount of time spent on exploring the project opportunities is that less time was left for extensive user validation and interface, manufacturing and business details. More extensive tests can, for example, show the richness of stories and interactions that different children come up with in different settings. Techniques and theory regarding these matters is learnt and applied more specifically in assignments, and students can choose more concrete projects if their competency development asks for this.

A main advantage of the explorative approach is, besides the opportunities for building a vision and inspiration gained for many new projects, that the final result is an, in our view, innovative concept. It combines real-world and virtual images like, for example, Sony’s EyeToy system does (EyeToy, 2009), but its portability allows for more dynamic movies and lets the children gain inspiration from the environment around them. It also pays more attention to imagination (actor) and authoring (director). A more extensive comparison with existing technologies and research is given in a paper that the students submitted together with their coach (Mendels et al., 2009). That paper is also an example of the integration of student work with research. All in all, the project places itself in the intersection of design, engineering and science, with a focus towards design.

5 Design case 2: locative games

A team of four second year ID Students, (Bastiaan Ekeler, Freek Boesten, Vic van Hensberg and Nick Muris) were asked to produce a location-based game for the Media and Culture group of the University of Amsterdam (UvA) and Waag Society. Waag Society is a mediablab in Amsterdam, the Netherlands that produced in cooperation with the UvA, a generic locative software platform for educational GPS-games (mobile learning game kit – later called 7Scenes). One of the aim of the project was to test the generic GPS software of UvA/Waag Society.

The first project week focused on exploring in context. Students visited a locative game festival in Amsterdam, called ‘come out and play’, that got them a fast but practical familiarisation with the phenomenon of locative gaming. A period of brainstorming sessions followed combined with research of GPS platforms, thus using the two strategies of making and thinking to generate information in order to get insight into the design opportunity and solution domain. The students investigated various platforms. The team compared Waag society’s software (MLGK) with M-Scafes and chose the latter. Students tested the combined hardware and software extensively because they were determined to present a game that really worked.

Because at that time there were already a number of location-based games tested in a prototypical stage, the team decided to take the opportunity to learn from them. Waag society’s first location-based game was thoroughly researched and conclusions were that in a locative game a narrative is of relatively small importance and the game play should not be too complicated. Usually players do not have more than 2 days to play the game and a complicated narrative combined with elaborated game play on a PDA that takes some time to master is less entertaining than a relatively easy game with a higher fun-level.

The students developed the requirements through exploration, analysis and reflection during the design process. They set out to produce a game with a high fun level that made good use of the characteristics of the location-based game-genre. First they decided that
the game should be constructed as one overall location-based game with sub-games. They explored the requirements further in a more *hands-on* approach. For the overall game the ‘walk the line’ game play was developed: the GPS devise was implemented in a foam ball with led’s on the side. As long as the led’s were flickering, there was a gps-fix and the game worked. The ball had to be moved as close as possible to a virtual line that was projected on the outskirts of Eindhoven, an area with sports-facilities, woods, etc. and made visible on a PDA (Figure 5). The PDA beeped steadily when the ball was close to the line but started to beep faster when the ball was moved from the line. This meant that real-world-obstacles such as buildings and streams required creative solutions such as throwing the ball to overcome the obstacles.

**Figure 5** A screenshot of the walk the line game showing the straight line that players have to follow as close as possible (see online version for colours)
Sub-games were developed for the game, which also run on the M-Scapes platform. One of them was a version of the old-time computer game PONG: the ball with the GPS devise, being the racket, had to be moved from one end of a field to the other, to hit the virtual ball on the PDA. This is illustrated by the following scenario:

Three boys, Mark, Tim and Josh decide to play the Walk The Line game. They meet up at the outskirts of Eindhoven and start the game. ‘Let’s start exploring the area’, says Tim. Josh who is holding the ball, sees, the lights on the ball flicker and Mark, who is holding the PDA sees the exact route that the ball has to take. Next, the team starts to follow the line with the ball as close as possible to it. After a while, they run into a canal. Josh quickly runs to the bridge a little further down, and crosses to the other side. When he is close to Mark and Tim they by throw the ball to him. ‘Well done’, says Mark, ‘It stayed really close to the line!’. When they get to the first sub-game location, the GPS system starts a sub-game. The team has to play the PONG game. Josh runs to the right, to the left and backwards and forwards, as directed by Mark. When they have scored three points, they can continue to follow the line. After having done a few more games and having skirted a few more obstacles the team arrives at the end of the line the results are saved in a high-score system. They are proud that they have reached number three in the high-score list.

The team produced a meaningful game with a new technology, as became clear during user confrontation to validate the design. They made good use of existing research and where there was no existing research they set up their own research. Students contributed to the growing community of location-based game developers and were invited to present their game at a locative game festival in Bristol, where the HP research lab is situated.

The reason of the success of the game was its simplicity: the gamers understood instantly how it worked and what the challenges were. Players ventured out to places they never went before and had to be inventive not to move the ball too far from the straight line. Furthermore, the sub-games provided the extra fun location-based games need. In the end, the game looked surprisingly simple. And – for a complicated project like this – that is one of the biggest compliments a designer-to-be can get.

Like the previous example of the ‘Junior Director’ (Section 4), these students also used an explorative approach with new technology, resulting in innovative opportunities for exploration and play. This design too combines the real-world and a virtual one, thus using the benefits of both worlds and letting players explore their physical environment in new ways and be creative to find solutions when both worlds seem to clash.

6 Design case 3: open-ended games for children

The purpose of the project was to design open-ended play objects for children. It was a second year Master Student project of 16 weeks. The intelligent objects should allow children to explore movements together with other children, using sensors to detect children’s movements and actuators to provide motivating feedback about their movements. The objects should be able to exchange information using wireless communication to stimulate children playing together. The overall vision on designing for open-ended play is that you design objects that allow players to create their game goals and rules, without providing predetermined goals and rules. The challenge for the designer is to iteratively explore whether the opportunities provided have enough and appropriate appeal for the players to create various game goals and rules. This is a research topic on which we have already run other design research projects (e.g. Bekker et al., 2008).
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The design created by Jos Verbeek is the ColourFlare. The ColourFlare is an object that can be carried in one hand, that changes colour when rolled, and that starts blinking when shaken (see Figure 6). When an object blinks it can send its colour to other objects in the neighbourhood using infra-red technology. The ColourFlare allows children to use their creativity to make their own games in which they allocate meaning to the behaviour of the object when shaken and rolled. Children will have to discuss ideas for game goals and rules, and thus also practice their social interaction and negotiating skills.

There were various educational challenges for the student in how to design an interactive toy for children. The student had to examine the user-group characteristics and their interests, how to design for open-ended play, that is, opportunities for creating goals, challenges and diverse interaction patterns, such as competition and or collaboration. Furthermore, he had to explore how the form might influence opportunities for play, and look into technological solutions for sensor and actuator combinations and software describing rules that determine behaviour of the sensor and actuator combinations. Jos used the RT design process to develop his solution by continuously trying, building, testing and analysing.

The ColourFlare entices children to make various movements, and exchange signals, thus stimulating social interaction between the players. A form study was conducted to examine how different shapes influence how children would grasp the objects and to express that the objects can send and receive colours. Another factor that influenced the design was the decision that the objects should be seen as personal objects. Thus the shape should allow rolling, but when rolling the object it should be more likely to stay close to the player, instead of it being rolled from one player to the next.

The use of the ColourFlare is described in the following scenario:

Dennis, Megan, Rob and Peter want to play a game with the ColourFlares. After some wild ideas have been proposed – and dismissed – Peter comes up with the idea of doing a game of tag. The goal is to pick a colour and try and make all the other ColourFlares the same colour. They start the game and run after each other, trying to send a colour to somebody else, but also hiding to prevent from getting a different colour. Dennis is the first to succeed in making Megan’s ColourFlare green. Megan is now in Dennis’ team and helps him to make the other ColourFlares green. Rob has made Peter’s ColourFlare red, so they now form a team playing against the other two. It is a very exciting game, and in the end the green team manages to conquer the other two. Green wins!

Figure 6 Children playing with the ColourFlare and the ColourFlare prototypes (see online version for colours)
To validate whether children really enjoyed playing with the ColourFlare Jos Verbeek conducted various user tests during the design process. Early in the design process Jos conducted a user test with eight children in three groups. He created a variation of shapes (synthesis) and checked how various shapes influenced children’s playing behaviour, whether children enjoyed creating their own games and whether the children understood the interaction opportunities (analysis). The test helped him select an overall form and choose the final interaction opportunities of rolling and shaking, and resulted in further refining his vision about open-ended play.

For the area integrating technology Jos examined various sensor-actuator platforms before selecting to create his own set-up with an Arduino microcontroller. He created a modular software program that can be reused for different versions of the ColourFlare (e.g. with different output modalities). A software program was written to manage the protocol between the sensor (accelerometer) and the LED feedback, and the communication protocol between different ColourFlares. The software describes the predetermined rules about how the output of the accelerometer is interpreted and translated into changes, and the rules for sending and receiving infrared signals.

After creating five fully functioning prototypes he conducted another user test in which he examined whether children could use their creativity to create their own games and whether the objects with the sending and receiving functionality stimulated social interaction. For the competency area of user focus he collected data using observational and self-reporting techniques. He analysed the data using a combination of qualitative and quantitative approaches. A total of 19 children played with the ColourFlares in groups of 3–4 children. They made up several games in sessions of about 40 min long. After playing with the ColourFlare children were asked to fill in a questionnaire addressing dimensions related to how players’ game experience (Poels et al., 2007) to gather data about children’s opinion about aspects such as fun, immersion, challenges, social interaction and physical activity. The findings show that they created many different games (an average of six games per group) in which various meanings were attributed to the rolling and shaking functionality. In a majority of the cases children created games where the functionality of the ColourFlare was used to trigger social interaction. The user test showed that children liked creating their own games, that it stimulated physical activity and social interaction. Thus, the intentions of the ColourFlare of allowing children to practice various skills through PI were assessed in acceptable manner for a student project. Future work should show whether such open-ended play object would stand the test of being fun for a longer period of time.

The work of Jos Verbeek was written up and presented at a conference workshop (Bekker and Sturm, 2009). Furthermore, the design of the prototype was used by Eva Hopma, another first-year Master student, to examine the influence of output modalities on the games that children play. This work was also written up and presented at a conference by the student (Hopma et al., 2009).

This project places itself in the intersection of design, engineering and science, with slightly more emphasis on engineering and science than on design. Similar as in the previous two design cases, Jos Verbeek, used an explorative approach with new technology, resulting in innovative opportunities for exploration, social interaction and play. This design allows children to jointly create their own games and to explore their physical environment in new ways.
7 Conclusion

Within the Department of ID, we aim at educating unique opportunity creators for societal transformation through the design of intelligent systems, products and related services. Both our focus and our approach characterise our specific ID Department. Although teaching the design of intelligent products and services by combining competency-centred learning, the reflective transformative design process and the integration of education and research are a challenging approach, the overall approach so far appears to be beneficial.

The students learn to develop and integrate their competencies in projects as well as assignments and modules. Looking at the results from our students, as exemplified by the three projects and one assignment form PI presented in this paper, they are able to develop their vision on design through their (in general) innovative designs. Especially, we showed that a theme like PI is well-suited to focus on the creation of opportunities for people, like an open-ended physical game or design for exploration.

We see the first signs that our students are able to merge the paradigms of design, engineering and science, thus having an eye for:

1. both understanding the world as well as transforming it
2. being able to focus on both humans and technology
3. making use of both explicit (e.g. in literature) and implicit knowledge (also referred to as intuition) (Bartneck and Rauterberg, 2007).

The three projects show that students are able to ideate within new solutions spaces, build these sometimes very complex systems and validate their designs and vision within society. Moreover, our experiences indicate that the reflective transformative design process encourages students to go through a highly iterative process together with users, thus exploring the edge of technological possibilities in search for innovative solutions. Nevertheless, we have also learned that this highly iterative character can sometimes be disadvantageous for the depth of the results. Therefore, we are currently exploring how we can set up a series of projects, so new students can start with the outcome of previous projects, by setting a new focus without duplicating the previous project.

Our project-based curriculum provides students with a unique opportunity to apply knowledge to diverse design projects, often combined with real clients, in order to develop their competencies. Our theme of PI functions well as one of the areas within the Department of ID and benefits from interaction with people who have expertise in other areas. Especially, the link between education and research and external partners, provides all people involved with opportunities to develop their competencies. So, next to the students who learned through reflection, coaches and clients within the theme also learn through the results of the theme and through the collaboration with others who often have different expertise and competencies. For example, the project resulting in the ‘ColourFlare’ is directly coupled to research within the department.

So, can one say whether our educational model is successful and can the theme of PI spread a new light on toys, games and entertainment? These are tricky questions to answer. But without wanting to give the impression of being too enthusiastic and not being critical about our own model, we have several indicators that point towards quality and appreciation. Firstly, every year we have dozens of students, both Bachelor and Masters that get a paper or poster accepted at an (international) peer-reviewed conference.
and a few students who win design awards. Secondly, the first accreditation in 2007 after the start of the entire department in 2001 supports our educational model and underlines the importance of this approach, although they are concerned about, for example, the labour-intensive way of teaching. Finally, we get many responses from industrial partners who like to cooperate in projects as clients and who provide us with positive feedback about the program, such as this quote from Bill Buxton, principal researcher at Microsoft Research: “The work that their students do is phenomenal. In addition to their talent, this is also due to the quality of the teaching.”

Our educational approach stimulates design students to create opportunities, to set a vision for the field and to transform society. We leave the judgement for now to you if PI makes a first step towards these goals and if the projects and assignment discussed in this paper redefine toys, games and entertainment products. The preliminary user studies support that we are on an interesting and valuable track, but it will take a few years, before we can actually start transforming society with commercial designs from our students in the field of PI.

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References

Redefining toys, games and entertainment products


